SDO: a short overview (with emphasis on AIA)

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SDO: the Solar Dynamics Observatory

SDO's goal is to understand the solar variations that influence life on Earth and humanity's technological systems by determining:

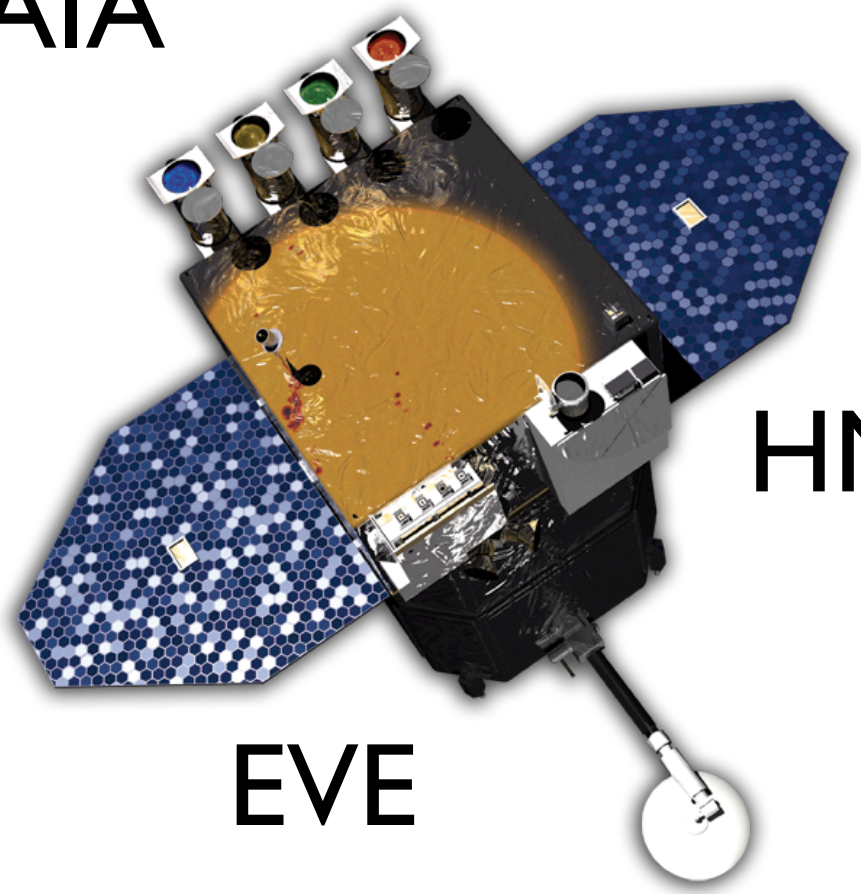
- how the Sun's magnetic field is generated and structured
- how the stored magnetic energy is converted and released into the heliosphere and geospace in the form of solar wind, energetic particles, and variations in the solar irradiance.

SDO has been launched in February 2010 and just finished performing its commissioning. It's currently in a geostationary orbit with 28.5° inclination

SDO Instruments

- **AIA**: the Atmospheric Imaging Assembly takes images of the solar atmosphere in EUV and UV. Data will consist of images of the Sun in 8 wavelengths every 10 seconds.
- **EVE**: the Extreme Ultraviolet Variability Experiment measures the solar EUV spectral irradiance to understand variations on the timescales which influence Earth's climate and near-Earth space.
- **HMI**: the Helioseismic and Magnetic Imager measures the motion of the solar photosphere to study solar oscillations and the polarization in a spectral line to study all three components of the vector of the photospheric magnetic field.

AIA



HMI

EVE

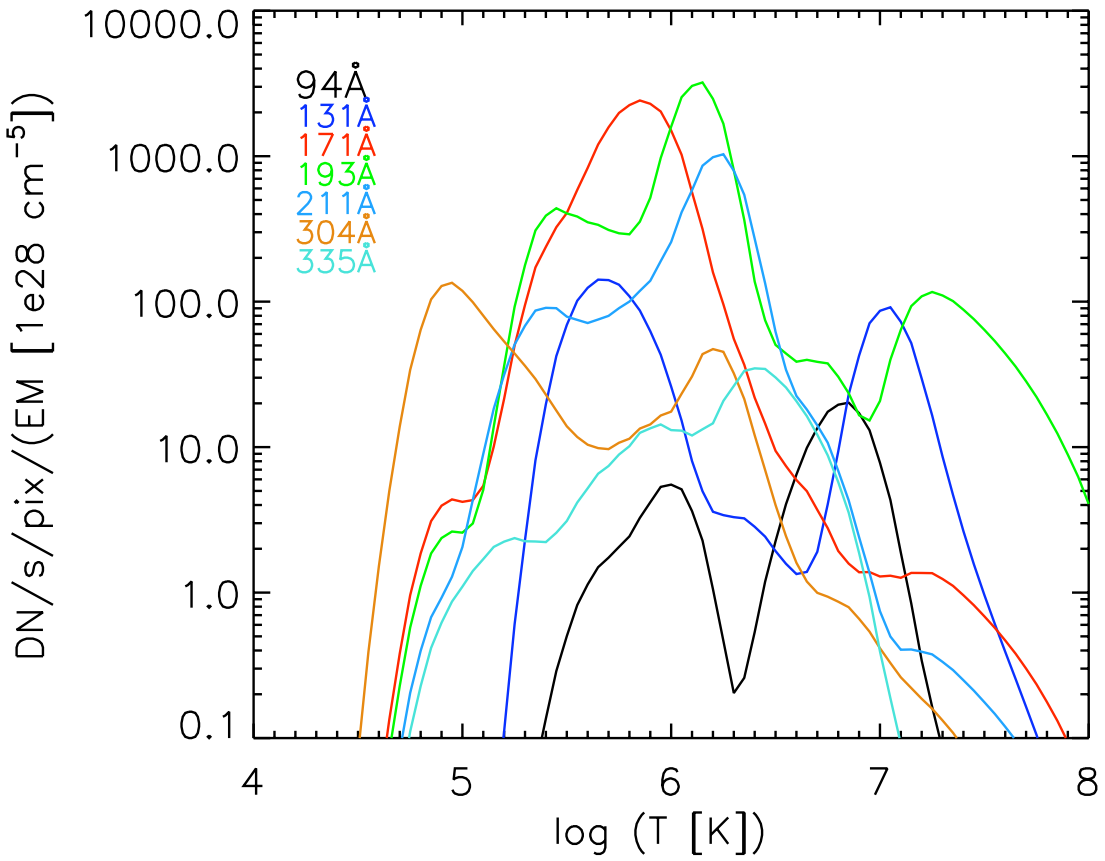
high gain downlink antenna sends data to dedicated ground station in Las Cruces, NM

AIA

- 4 telescopes covering multiple narrowband filters in EUV (~90-330 A) and UV
- Full Sun field of view plus lower corona (~40 arcmin)
- Temperature coverage:

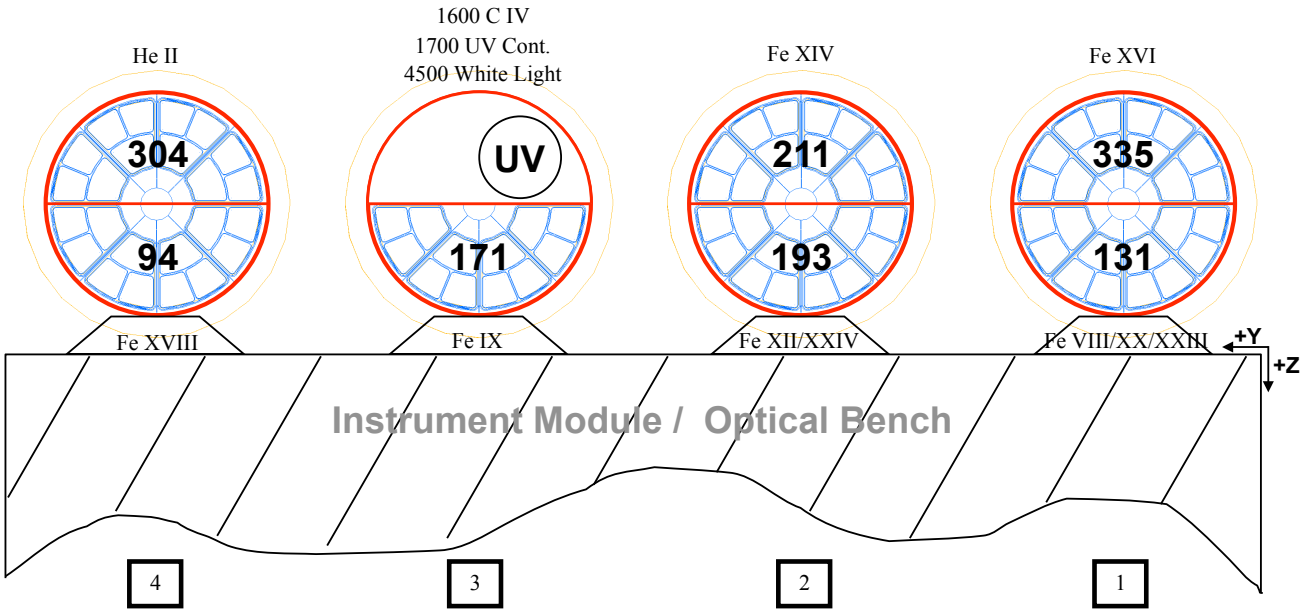
Channel	Ion	log(T)
Visible+UV	Cont., CIV	3.7,5.0
304	HeII	4.7
171	FeIX	5.8
193	FeXII, FeXXIV	6.1, 7.3
211	FeXIV	6.3
335	FeXVI	6.4
94	FeXVIII	6.8
131	FeXX, FeXXIII	7.0,7.2

Temperature response:

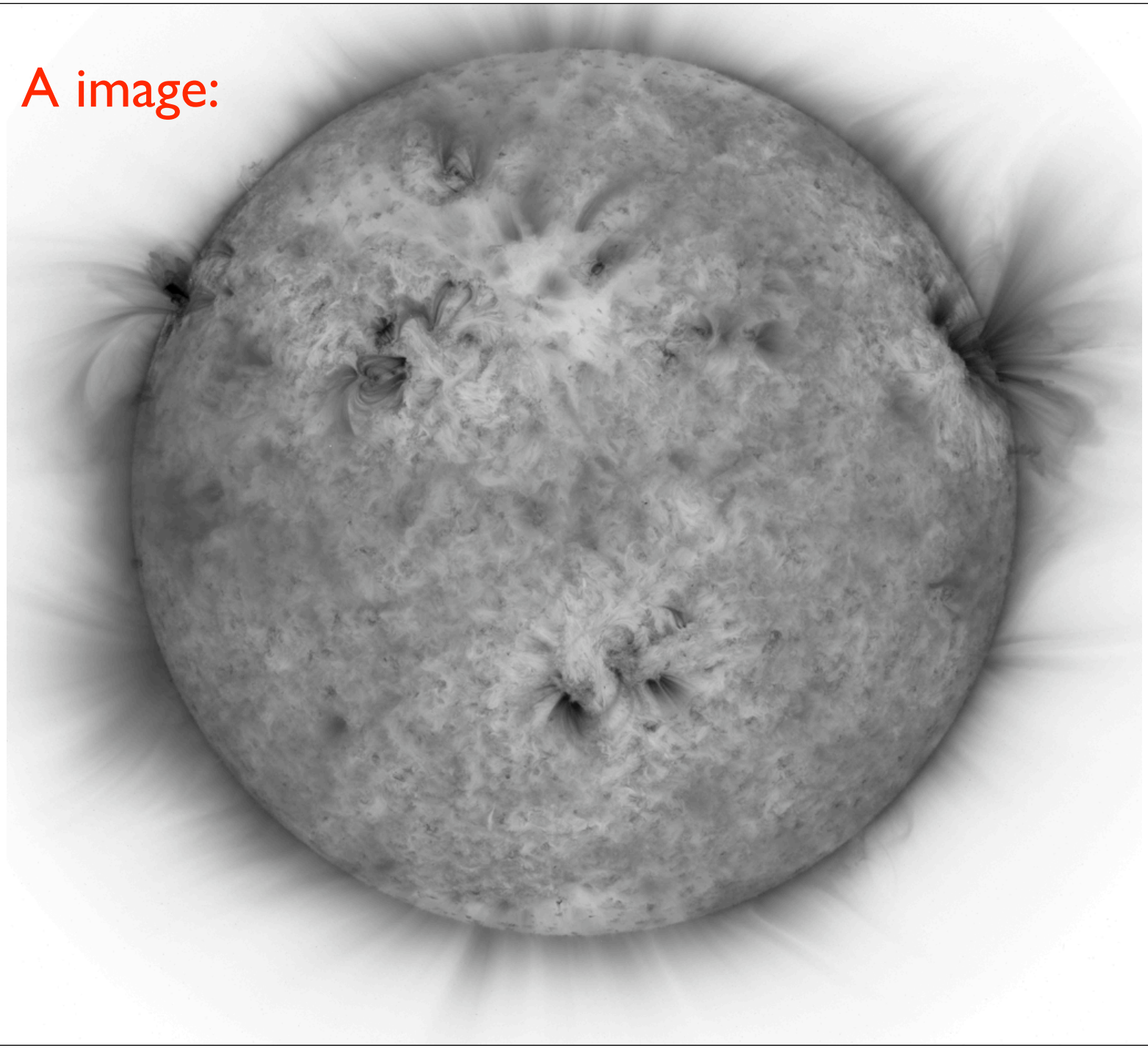


AIA Telescopes & Wavelengths

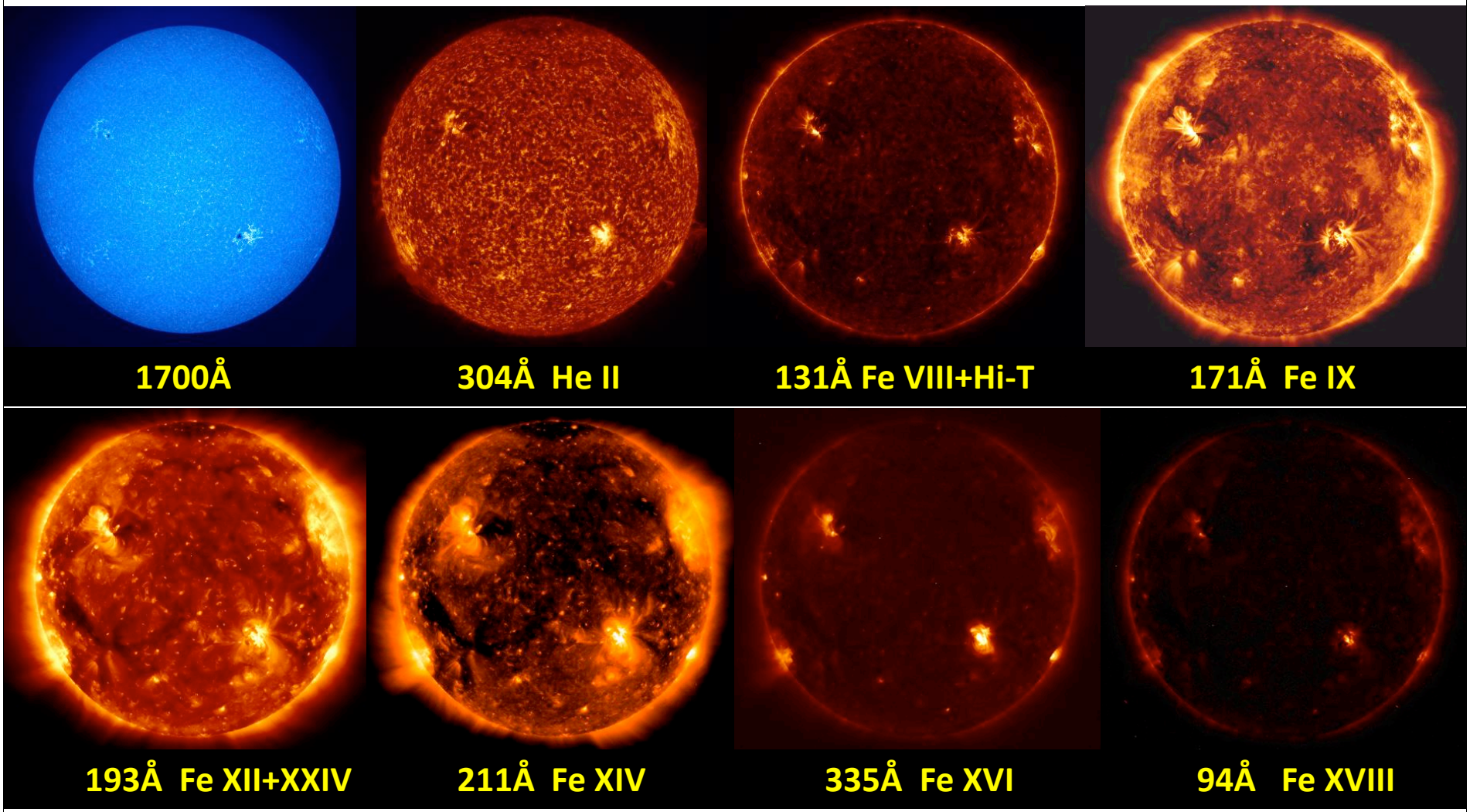
Looking at the AIA from the Sun



171 A image:



A First Look at AIA: 31 March 2010



Observation modes

- Constraint: ~2.5 seconds to read the CCD, ~3 seconds exposure time on QS
- AEC: the two hotter channels (94 A, 131A) will use AEC, the cooler channels not
- Most of the time, a constant "synoptic program" will be run at 10 s or 12 s cadence switching channel every 5 s or 6 s (tradeoff is slightly longer exposure time and lower compression)
- Lossless compression used as follows: image data is "quantized" first (i.e. all pixels with, say, 1000DN to 1010DN will be assigned a value of 1005DN) and then lossless rice compression is applied

Data access

- JSOC site: uses a very involved interface with complex query structures http://jsoc.stanford.edu/ajax/lookdata.html
- VSO (Virtual Solar Observatory): much easier data access on the web (not quite ready yet but will soon be)

EVE

- Full Sun spectrograph in EUV (composed of several different instruments) covering 50A-1050A spectra at 1A resolution with a 10s cadence (MEGS A, MEGS B)
- Irradiance measurements in several EUV bandpasses with a 0.25s cadence (ESP, MEGS P)
- Images from a pinhole (26 μm) camera with a 10 seconds cadence (MEGS-SAM) - covers 1A to 70A, can be used for spectroscopy in single photon mode.

Level	Description	Components	Wavelength Coverage	Wavelength Sampling	Temporal Sampling	Time Span of Data File	Daily size (GB)	Latency of Availability
L0C	**Space Weather Product:** Crudely calibrated irradiances* (from Ka-Band data)	ESP bands + quads (flare)	0.1-7, 18.2, 25.6, 30.4, 36.6 nm	broadband ~4-nm	1-min	Latest 15-min and current 1-day (growing file)	0.004	<15 min
		MEGS-P	121-122 nm	1-nm				
		MEGS-A, B	5-105 nm	1-nm	1-min		0.005	
		MEGS-A, B, proxies	Select lines and bands**	Varies by band	1-min		0.01	
L0CS	**Fastest Space Weather Product**: Crudely calibrated irradiances* with least latency (from S-Band)	ESP bands + quads (flares)	0.1-7, 18.2, 25.6, 30.4, 36.6 nm	broadband ~4-nm	1-min	Latest 15-min and current 1-day (growing file)	0.005	< 1 min
		MEGS-P	121-122 nm	1-nm				
		XRS & SEM model	Proxies	Varies by band				
L1	**Photometer Data:** fully calibrated and corrected photometer irradiances	ESP	0.1-7, 18.2, 25.6, 30.4, 36.6 nm	~4-nm	1/4-sec	1-hour	0.03	1 Day
		SAM	0.1-7 nm***	0.1-1-nm	1- & 5-min		varies	
		MEGS-P	121-122 nm	~1-nm	1/4-sec		0.006	
L2	**Spectra**: fully calibrated and corrected spectral irradiances at instrument resolution	MEGS-A, B	5-105 nm	0.02 nm	10-sec	1-hour	1.2	1-2 Day
L2	**Lines & Broadband irradiances:** fully calibrated and corrected photometer irradiances and extracted spectral lines and bands	MEGS-A, B, P, ESP	select lines & bands	Varies by band	10-sec	1-hour	0.01	1-2 Day
L3	**Merged Spectra:** fully calibrated, corrected, and merged spectral irradiances	ESP, SAM, MEGS-A, MEGS-B, MEGS-P	0.1-105 nm	0.02, 0.1 & 1 nm	1-day	1-day	<0.001	1-2 Day

*All products are corrected to 1-AU except L0C and L0CS.

** Lines spanning Log T = 3.8-7.1, plus AIA and ESP bands.

*** SAM is a research project, L1A will have 4 element event list: time, location (x,y), and energy.

HMI

- HMI provides helioseismology data (don't know much about those) and magnetograms
- Images are 4096x4096 pixels @ 0.5 arcesconds/pixel
- Line-of-sight magnetograms available with a 90 seconds cadence
- Vector magnetograms from 12-min averaged data